APPLICATION OF SCANNING ELECTRON MICROSCOPY IN THE TAXONOMY OF CLADOCERA[1]

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(With eight plates containing forty-nine figures)

Taxonomic diagnostic characters of the freshwater Cladocera were examined using Scanning Electron Microscope. The species are characterised by external markings on the surface of the carapace, presence of spines on the posteroventral corner of the shell, the number and arrangement of spines on the postabdomen, number of pores on the head shield, ornamentation in the ephippial eggs etc. The application of SEM to the taxonomic studies of the freshwater Cladocera provides diagnostic capabilities not available with a light microscope. It is desirable to develop a key, coupled with a reference atlas of Scanning Electron Micrographs, illustrating diagnostic characters of freshwater Cladocera species.

INTRODUCTION

In taxonomic studies of the freshwater Cladocera, morphological criteria have, in most instances, provided the bulk of descriptive material used in classification. Surprisingly, Scanning Electron Microsocopy (SEM) has been utilised in only a few instances in examination of diagnostic characters of freshwater Cladocera (Amoros 1980, Dumont 1981a, Dumont *et al.* 1981b, Frey 1982), although it has been utilised extensively to study other aspects of Cladocera biology (Guldner 1969, Dumont & Van de Velde 1976, Schultz & Kennedy 1976, Schlecht 1977, Schlecht 1979, Seiman & Larsen 1979, Zahid 1981, Crittenden 1981). The present study presents a Scanning Electron Microscopic study of the freshwater Cladocera from southern Tamil Nadu.

MATERIAL AND METHODS

Plankton nets with 36 cm diameter and mesh size 90 m were used to collect the different species of Cladocera. The net was dragged through vegetation and close to the bottom of shallow waters in marshes. Oblique hauls were taken to obtain Cladocera from the shores of man-made reservoirs and ponds. The samples collected from the field were preserved in 5% and 10% formalin with sugar or in 95% glycerine alcohol. The preserved samples were isolated and cleaned. The dust-free samples were dehydrated with acetone and then air-dried. The specimens were coated with silver in a Hitachi vaccuum coater HUS 5 GB. The important diagnostic features were photographed using Scanning Electron Microscope, Hitachi S 450.

OBSERVATION

The character that differentiates *Pseudosida bidentata* and *P. szalayi* is a spine-like projection on the distal margin of the postabdomen. Fig. 1 provides this diagnostic morphological character not available with the light microscope.

Figs. 2 - 6 show the morphology of sexual eggs of *Daphnia projecta*, *Simocephalus vetulus elizabethae* and *Simocephalus acutirostratus*. Under high magnification (Figs. 4 and 6; 1500 x) the sexual eggs (*ephippia*) of *S. vetulus elizabethae* and *S. acutirostratus* show variation in their morphology. But these eggs under the light microscope appeared same except for the size.

Figs. 7 and 8 show the morphology of *Ceriodaphnia cornuta*. The honeycomb-like appearance of the surface of *C. cornuta* is a very important morphological character to identify this species.

Fig. 9 shows the hexagonal markings on the surface of sexual egg of *Moina micrura* which differentiates this species from *M. weismanni*, which consists of raised knobs. Likewise, the number of hooks on the tip of the male antennule is one of the diagnostic features to differentiate *M. micrura* from *M. weismanni*. Fig. 10 shows the presence of 4 well developed hooks in the antennule of *M. weismanni*.

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But in the case of *M. micrura*, there are three.

SEM Figs. 11 and 12 show the postabdomen and the pectens in the claw of *Ilyocryptus spinifer.* The number and arrangement of lateral denticles are clearly seen in the micrograph.

SEM Figs. 13 and 14 show the morphology of a chydorid cladoceran *Dadaya macrops.* The ornamentation on the surface of the shell of this species is unique and the SEM picture provides a clear morphology which is not available with the light microscope. Likewise, the pitted appearance in the shell of *Chydorus parvus* and fine granular structure of the shell of *Ch. ventricosus* and its postabdomen are clearly seen in the micrographs 15 – 18. The presence of posteroventral corner spine is a characteristic feature of a few species of chydoeid cladocesan. This important diagnostic feature can be seen in the species *Ch. barroisi*, which is not terminal; in *Dunhevedia crassa*, however, the spine is terminal (Figs. 20 and 22). The surface of the shell of *Pseudochydorus globossus* has hexagonal markings which are clear in SEM (Fig. 24). SEM Figs. 25 – 29 show the characteristic features of *Alona monacantha tridentata.* The presence of three connected head pores is one of the characteristic features of this species and is an important systematic tool to classify whether it belongs to the subfamily Chydorinae, which has two main pores plus two small pores in the head shield, or to the subfamily Aloninae, which has three main pores as in the case of *Amonacantha tridentata.* SEM Figs. 30 and 31 show the shell morphology of *A. davidi* and its postabdomen. The lateral groups of denticles and the claw pectens are clearly seen in SEM Fig. 31. *Grabtolebris testudinaria* is one of the rare littoral chydorid cladocera present in the marshes of tropical regions. The SEM picture provides a specific ornamentation confined to this species only. The ornamentation appears to resemble a brick wall. The presence of three posteroventral corner spines is clearly shown in Fig. 34. Figs. 36 and 37 show the ornamentation on the head shield and head pore. *Leydigia ciliata* is a littoral chydorid cladoceran present in reddish-brown turbid ponds of southern Tamil Nadu. Figs. 38– 43 show the morphology of the shell, postabdomen, pectens on the claw, shell surface of the male, male postabdomen with vas-deferens and the ornamentation on the sexual egg. The presence of pectens on the claw is a diagnostic feature which differentiates this species from *L. acanthocercoides*, which has no pectens on the claw (Smirnov 1971). *Biapertura karura*, a common chydorid present in the marshes of tropical regions, has three spines on the posteroventral corner and the ornamentation on the shell (Figs. 44– 46) are important morphological criteria which differentiate this species from *B. verrucosa*, another species co-occurring with *B. karura. Euryalona orientalis* is found throughout the tropical region and has a sinuation in the ventral margin and the ornamentation on the surface of the shell is an important character to differentiate this species from others. The size, number and arrangement of pectens on the claw of this species is also unique (Figs. 47– 49).

Discussion

The distinguishing features of the species of Cladocera are external markings on the surface of carapace, presence of spines on the postero-ventral corner of the shell, the number and arrangement of spines on the postabdomen, number of pores on the head shield, ornamentation in the ephippial eggs etc. It is apparent that the application of SEM to taxonomic studies of freshwater Cladocera can provide a valuable tool to the investigator, particularly if micrographs of diagnostic criteria could be gathered into a reference atlas. While morphological criteria should not be relied upon to the exclusion of other methods used in systematics (particularly in a group noted for ecomorphic variation), the SEM provides a diagnostic advantage not available with the light microscope.

Acknowledgements

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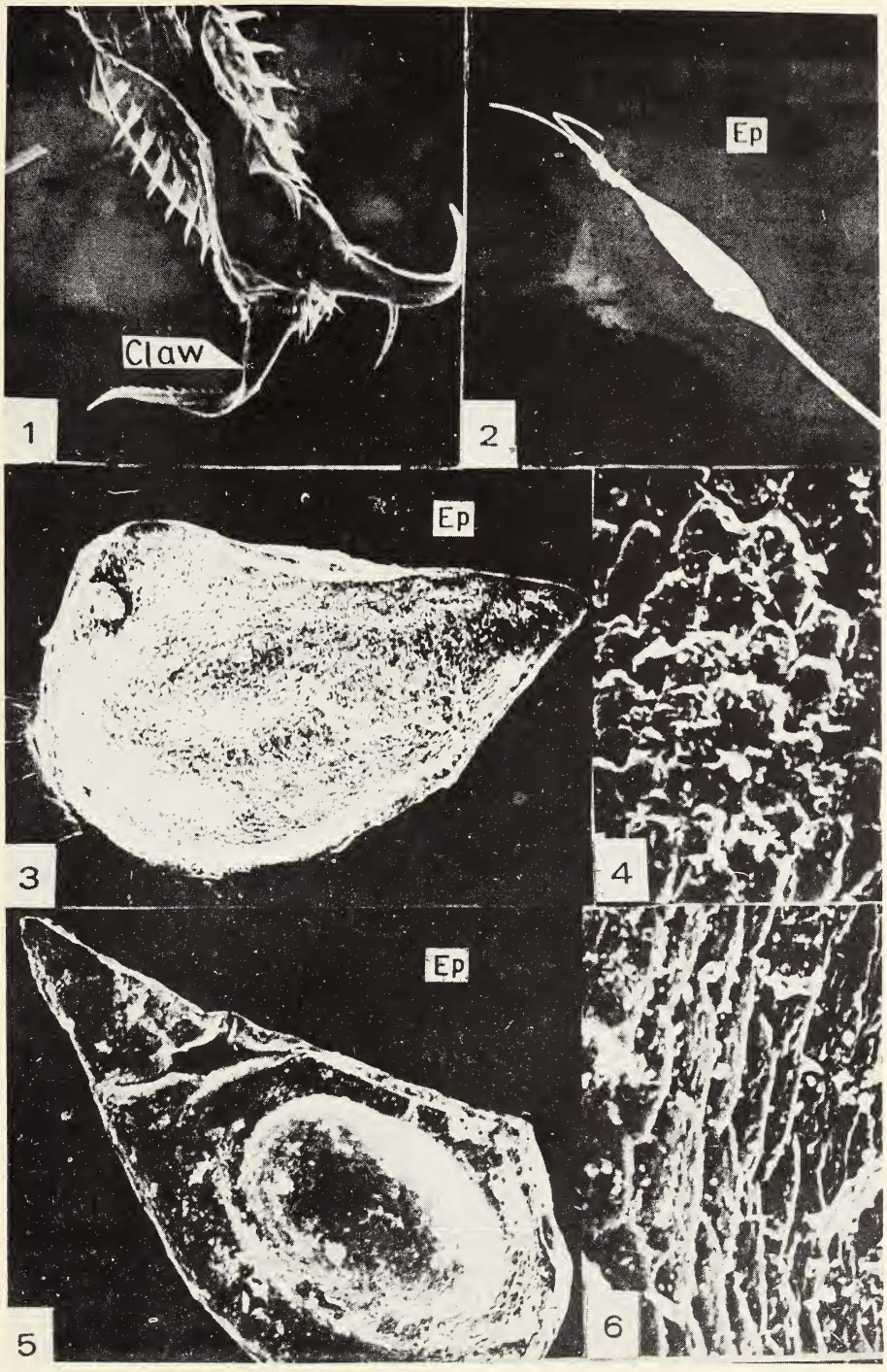
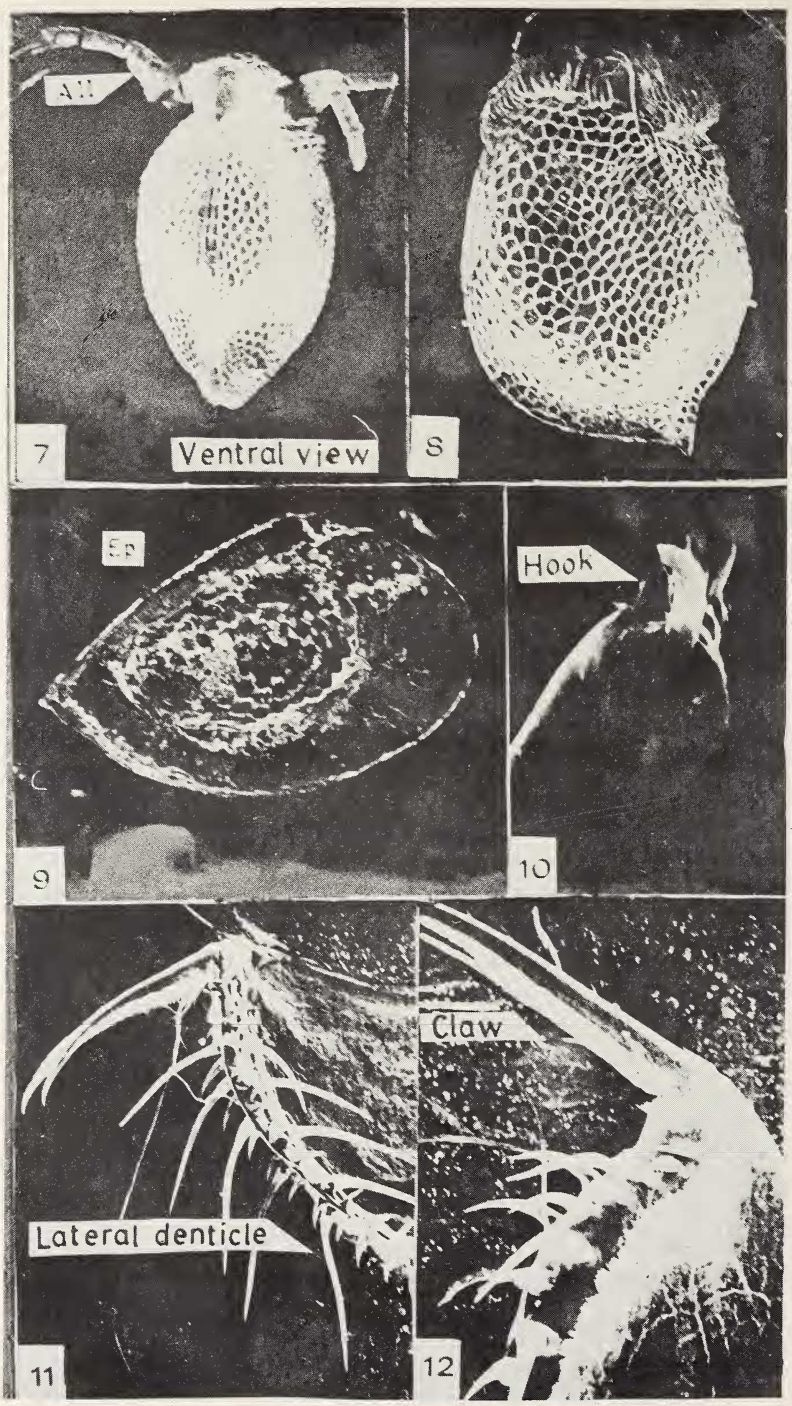
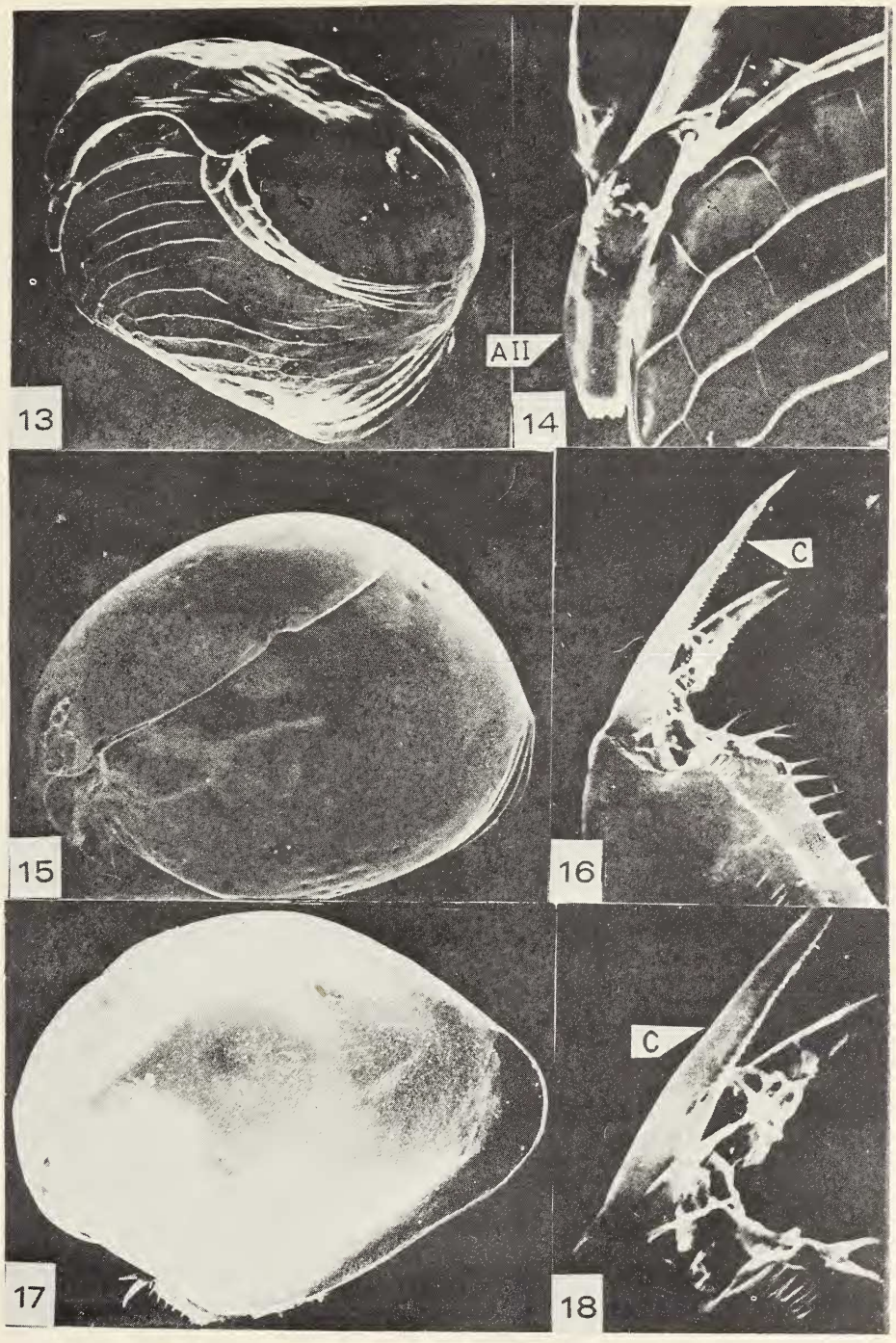


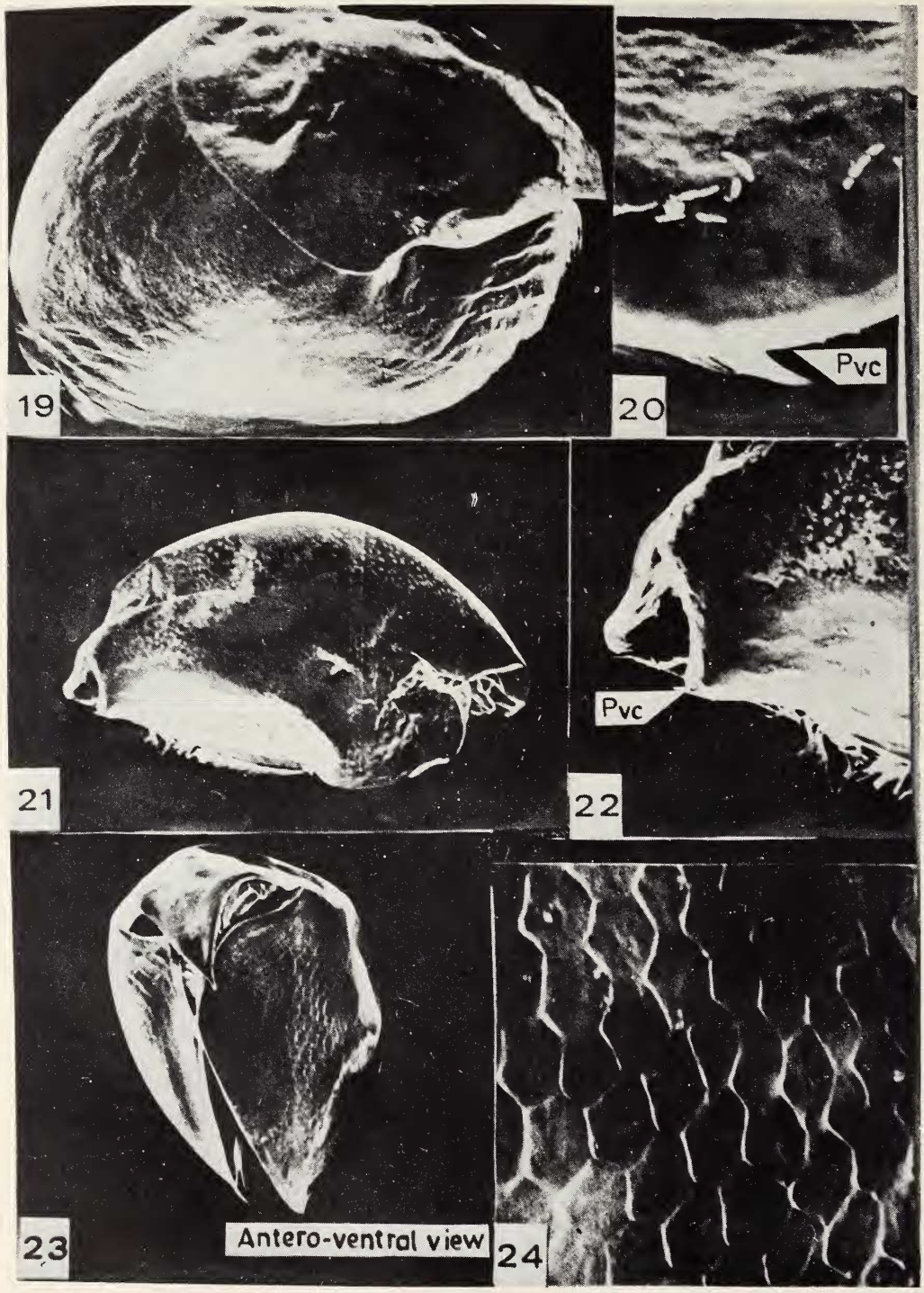
1. *Pseudosida bidentata*: female postabdomen; 2. *Daphnia projecta*: ephippia; 3. *Simocephalus vetulus elizabethae*: ephippia; 4. Ephippia: surface; 5. *Simocephalus acutirostratus*: ephippia; 6. Ephippia: surface.



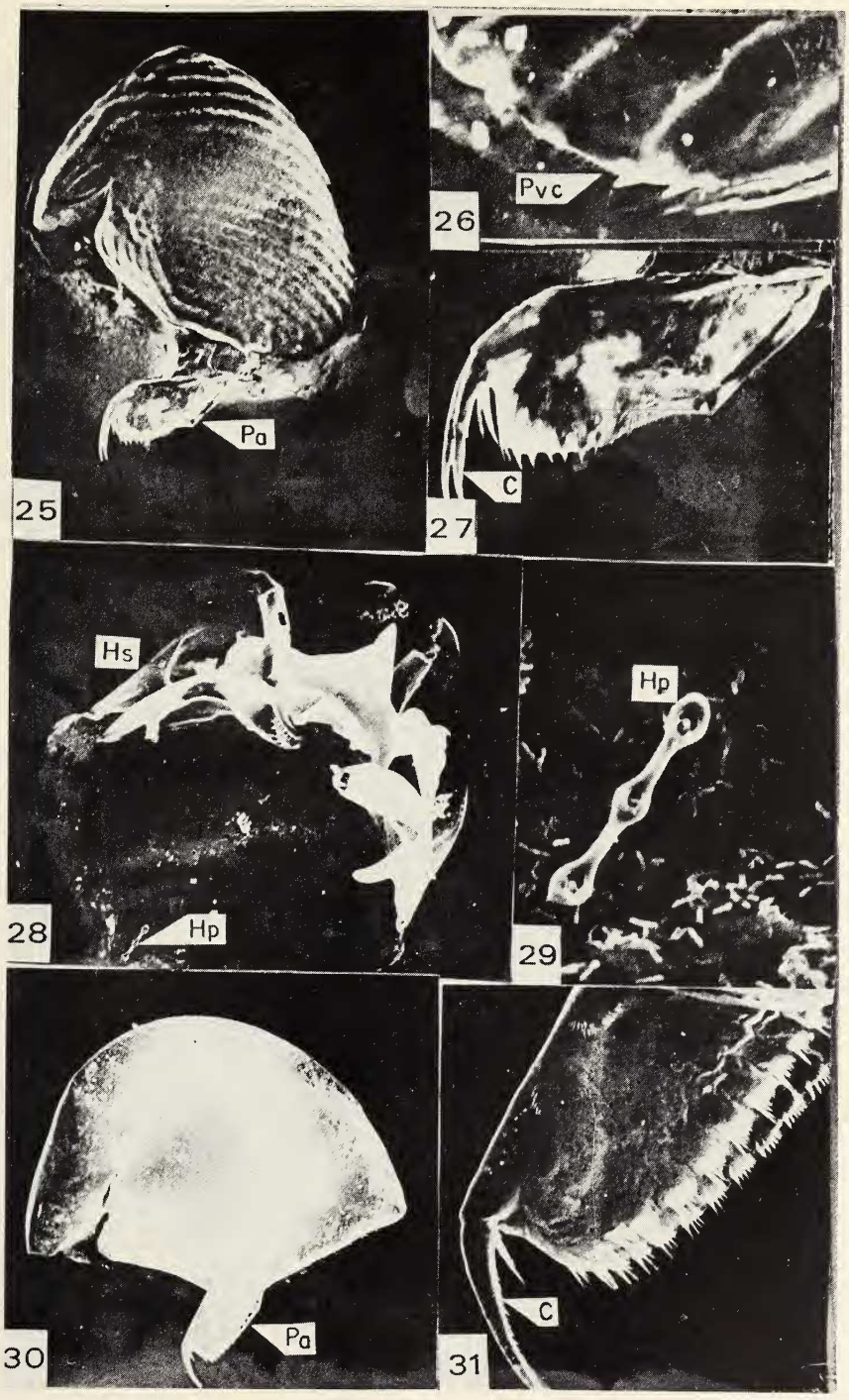
7. *Ceriodaphnia cornuta*: female ventral view; 8. Female lateral view; 9. *Moina micrura*: ephippia; 10. *Moina weismanni*: male antennule; 11. *Ilyocryptus spinifer*: female postabdomen; 12. Female: postabdomen enlarged.



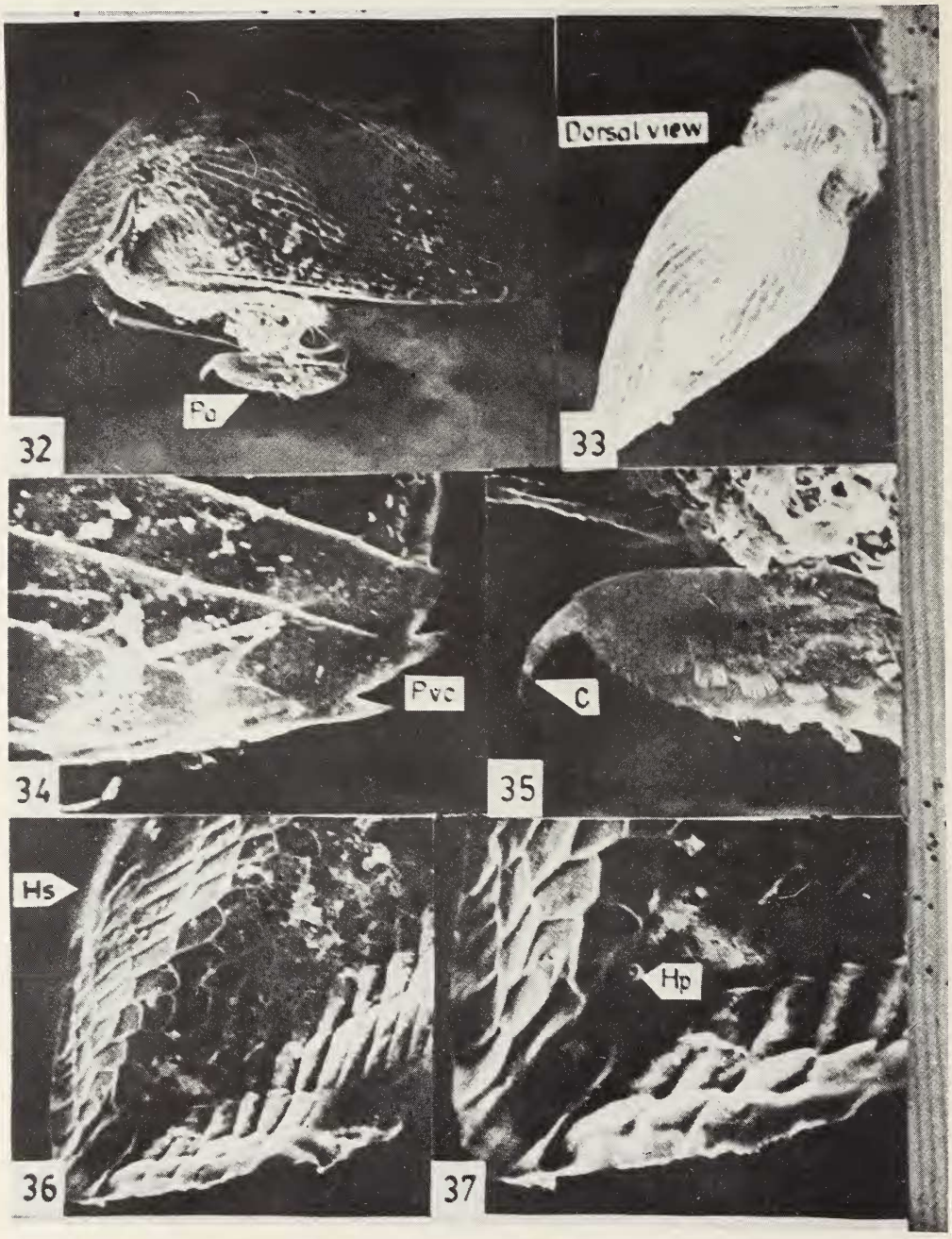
13. *Dadaya macrops*: female lateral view; 14. Female: antennule; 15. *Chydorus parvus*: female lateral view; 16. *Chydorus ventricosus*: female postabdomen; 17. Female: lateral view; 18. Female claw.



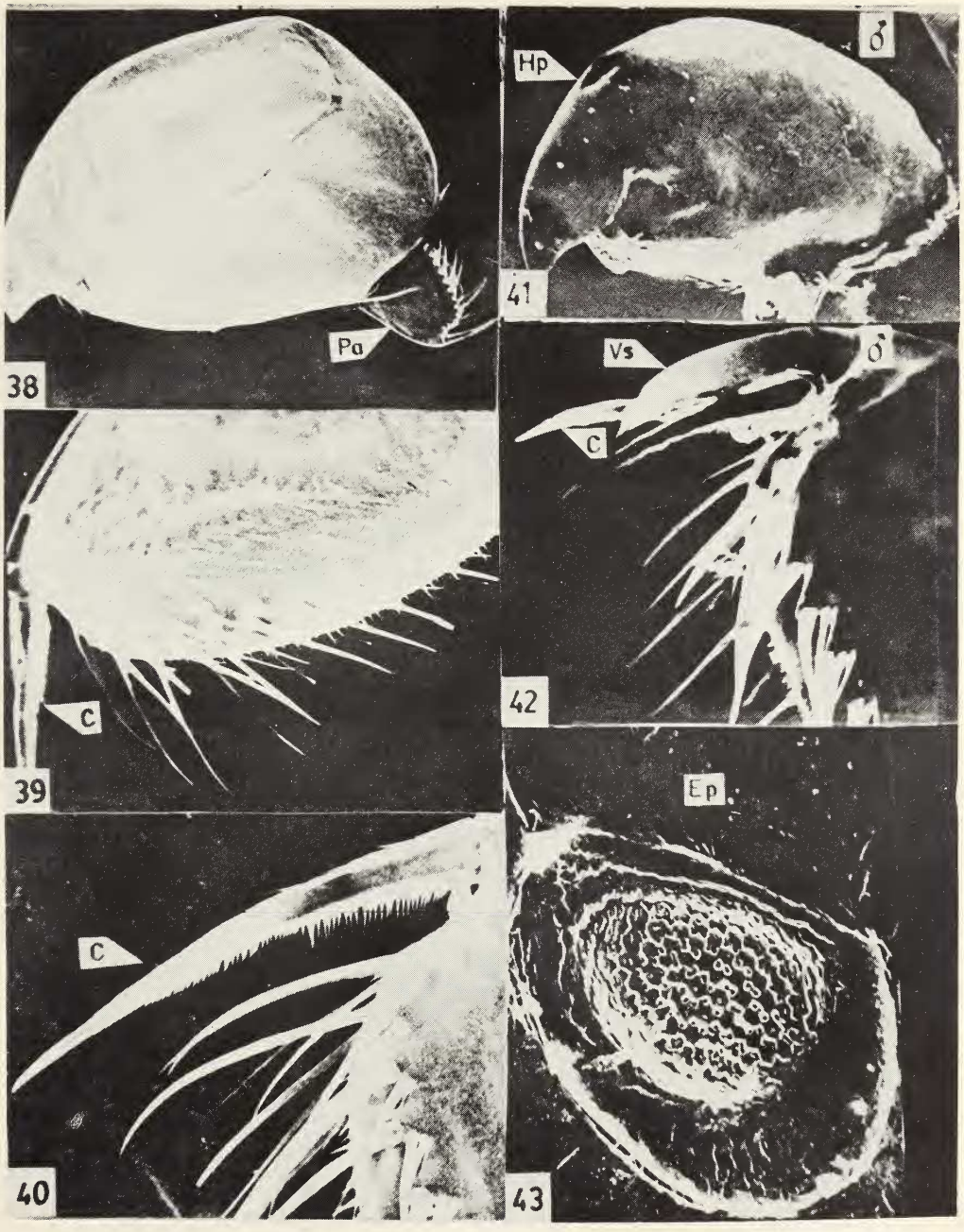
19. *Chydorus* sp.: female lateral view; 20. Posteroventral corner; 21. *Dunhevedia crassa*: female lateral view; 22. Posteroventral corner; 23. *Pseudochydorus globossus*: female ventral view; 24. Lateral surface of carapace.



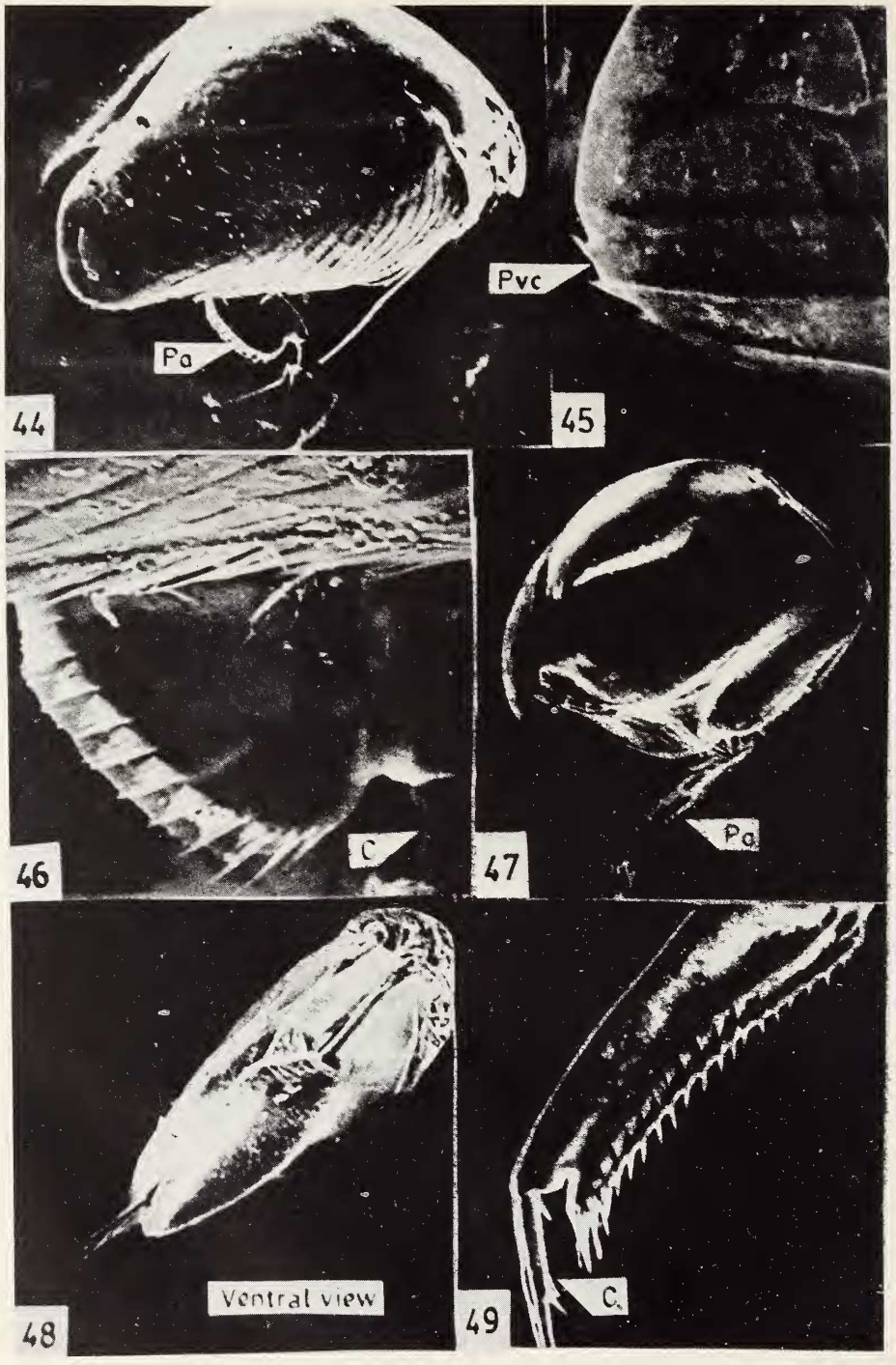
25. *Alona monacantha tridentata*: female lateral view; 26. Posteroventral corner spines; 27. Postabdomen; 28. Head shield; 29. Head pore; 30. *Alona davidi*: female lateral view; 31. Postabdomen.



32. *Grabtoleberis testudinaria*: female lateral view; 33. Female dorsal view; 34. Posteroventral corner spines; 35. Postabdomen; 36. Head shield; 37. Head pore



38. *Leydigia ciliata*: female lateral view; 39. Female postabdomen; 40. Female claw; 41. Male lateral view; 42. Male postabdomen; 43. Ephippia.



44. *Biapertura karua*: female lateral view; 45. Posteroventral corner; 46. Postabdomen; 47. *Eurualona orientalis*: female lateral view; 48. Ventral view; 49. Postabdomen.